PEDIATRIC RISK OF MORTALITY III (PRISMIII) SCORE AS A PREDICTOR OF MORTALITY IN PICU

Dissertation submitted for

M.D DEGREE EXAMINATION

BRANCH VII – PEDIATRIC MEDICINE

MADRAS MEDICAL COLLEGE

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

SEPTEMBER 2006

CERTIFICATE

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SPECIAL ACKNOWLEDGEMENT

I gratefully acknowledge and sincerely thank

Prof. Kalavathi Ponniraivan M.D., Dean, Madras Medical College, Chennai for granting me permission to utilize the facilities of the institution for my dissertation work.

ACKNOWLEDGEMENT

I am extremely thankful and grateful to our Respected Director, ***Prof. Mangayarkarasi Senguttuvan, M.D., D.C.H.,*** for having permitted me to do this dissertation work.

I thank with a deep sense of gratitude my guide and unit chief ***Prof. Saradha Suresh, M.D., Ph.D.,*** for the boundless affection, kind encouragement and constant support given by her throughout the study.

I am greatly indebted to ***Prof. Dr.R.Kulandai Kasthuri.,M.D., D.C.H.*** for the unstinted guidance given by her throughout my study.

I thank the dedicated Assistant professors of PICU and my unit, ***Dr.P.Ramachandran, Dr.S.Thangavelu , Dr.S.Shanthi , Dr.Annamalai Vijayaraghavan, Dr.D.Gunasingh, Dr.C.Subbulakshmi ,Dr.Luke Ravi Chelliah*** for their guidance and support.

I thank the Professors and the staff of the biochemistry and pathology department, ICH&HC, Chennai for the help they provided during this study

Above all, I thank the children and their parents, who gave me an opportunity to learn and do this study

CONTENTS

INTRODUCTION

Prognostication has always been the duty of a physician. This is perhaps particularly true in the case of critically ill patients. With progress in all specialities in pediatrics, pediatric critical care has also developed tremendously. Nowadays Pediatric intensive care units are becoming increasingly sophisticated in terms of equipment used and the types of therapy administered in various acute illnesses. The evaluation and prognostication of all cases admitted to the Pediatric Intensive Care Unit (PICU) is important for various reasons. Scoring systems aim at providing an objective measure of the severity and hence the prognosis of patients. They are also important for medical audit and in the comparison of cohorts of patients entering clinical trials. A scoring system is also a tool in resource management . It helps in allocation of limited PICU facilities and provides an index for the level of intervention appropriate for that patient. The PRISM III score is one of the most recent scoring systems of pediatric mortality. The outcome of pediatric intensive care has not been widely reported in India and few studies describe the use and validation of any scoring system. This study aims at using the PRISM III score in a PICU in a tertiary referral hospital in India to evaluate its usefulness.

SCORING SYSTEMS

Scoring Systems and their Need:

There is an increasing emphasis on the evaluation and monitoring of various aspects of health care services. Scoring systems aim at providing an objective and measurable value for any such service. The goal is to provide the highest quality of care with the available resources to achieve the best outcome. All scoring systems are designed to quantify and reduce a number of discreet but interrelated patient characteristics to a single value. This value can be used to further compare and analyse various aspects like disease severity, therapies used or final outcome. The scoring system forms the backbone of any hospital audit.

Scoring Systems in Critical Care:

Like in other areas of health care, intensive care also needs audit and evaluation of clinical effectiveness. Although various modalities of treatment are available, no strict guidelines exist for the likelihood of successful therapy. The clinical effectiveness of any therapy requires research to measure outcome. Outcome audit can be done by measurement of mortality, morbidity, disability, functional health status and quality of life. In general health care, death is infrequent and hence an insensitive measure

of outcome. However, in intensive care areas, deaths do offer a sensitive and appropriate measure. Thus, predicting mortality and the scoring systems, which do this, become a tool for evaluation of quality of care.

Scoring systems aim at an equation to estimate probability of outcome. Each system has a group of independent variables (case mix) and the dependent variable (death) in the form of a mathematical equation. The equation is applied to the current intensive care unit statistics and a death rate is derived. The actual and expected death rates are compared.

Scoring Systems: Historical Aspects and Examples:

Perhaps the first known scoring system developed was in the care of the newborn – the APGAR score [1], in 1953. Many unscientific observations and steps for resuscitation were practiced at the time. The APGAR score, which assessed objectively cardiovascular, pulmonary and neurologic systems, aimed to serve as a comparison of the results of obstetric practices, maternal sedation and efficacy of resuscitation. Glasgow Coma Scale [2], which was introduced in 1974 by Teasdale and Jenette for evaluating severity of the neurological insult, is another important scoring system that is widely used.

Applications of Scoring Systems:

Scoring systems provide a measurable, objective value for the outcome variable being studied. In the intensive care setting, most scores measure probability of mortality. This data is used for purposes of clinical research, performance assessment and resource allocation.

a. Clinical research: The scores are used as an objective measure to demonstrate equivalence of study and control patients in various therapeutic trials. Data from scoring systems are used for inclusion criteria to enroll patients within a specified severity or risk range. The data also enable risk stratification for outcome comparisons.

b. Performance assessment: Data from the scoring systems allows use of treatment resources within a given setup. Comparison between hospitals with similar patient populations as well as outcome of a single Intensive Care Unit over time can be performed with the help of these data.

c. Resource allocation: Data generated from various scoring systems can help in optimal allocation of resources based on the severity of illness and the therapeutic needs.

Use of Scoring Systems in the Pediatric ICU

Pediatric intensive care is a rapidly evolving area in pediatric medicine. A more complete understanding of the pathophysiological processes in critically ill infants and children has led to statistical refinements in intensive care units. It is important to develop methods for evaluation of this area of care. As PICUs are multidisciplinary in nature, generic classification systems, not confined to one area (e.g. trauma) but to critical care in general are important and necessary. These scoring systems must be applicable to patients with a wide variety of disease states.

Types of Scoring System:

Scoring systems can be developed for intensive care in general (e.g. APACHE, PRISM) or for specific conditions like trauma (e.g. TRISS – Trauma injury severity score). Scoring systems may be based on:

a. Anatomical extent of injury
b. Physiologic derangement
c. Types of intervention used.

Anatomical Extent of Injury:

Anatomic scoring systems are used for trauma in order to assess the extent of injury. Example for this is Pediatric Trauma Score[3.] Pediatric trauma score takes into account a child's size, the accessibility of airway, the systolic blood pressure, the level of consciousness and the presence or absence of wounds and fractures.

Therapeutic Intervention Scoring System and Clinical classification system[4]:

The type of intervention used in the intensive care setting is the third principle in the development of score. The number of therapeutic interventions a patient warrants is measured to reflect the severity and hence the prognosis

The Therapeutic Intervention scoring System (TISS) was the first scoring system used to assess critically ill pediatric patients. The patients were quantitatively evaluated for the amount of care received with the TISS and categorized qualitatively for severity of illness, Clinical Classification System (CCS).

The Clinical Classification System was defined as follows:

Class I (routine postoperative, not requiring intensive care)

Class II (physiologically stable patients requiring prophylactic overnight observation)

Class III (physiologically stable patients requiring intensive nursing and monitoring)

Class IV (physiologically unstable patients requiring intensive nursing and physician care)

The TISS scores and CCS classification were found to be consistent in mortality rates.

Physiology based Scoring Systems:

Physiological Stability Index (PSI) [5]:

Physiologic scoring systems measure physiological derangement as a disruption to homeostasis. Various physiologic parameters are weighted to reflect prognostic impact. These various physiological measurements come together as a score to reflect prognosis.

A physiology based classification system applicable to critically ill pediatric patients was developed and validated in 1982. This was the PSI or Physiological Stability Index. Each variable in PSI was assigned a score of 1, 3 or 5 which were interpreted as follows:

Score 1 = range abnormal but no need for change in therapy

Score 3 = abnormal with need for change in therapy

Score 5 = indicates immediate life-threatening situations.

E.g.PaO2 50-60 = score 1; 40-49 = score 3 and < 40 = score 5.

The PSI was validated based on CCS and TISS. From the data collected, a predicted mortality based on logistic regression analysis was constructed in which probability of death was determined from the PSI score. This was subsequently again validated by a multi-institutional cohort

Pediatric Risk of Mortality Score (PRISM Score) [6, 7]

The pediatric risk of mortality (PRISM) score was developed from the Physiology Stability Index. The number of physiological variables required for Pediatric Intensive Care Unit (PICU) mortality risk assessment was reduced while aiming for an objective weighting of remaining variables. Univariate and multivariate statistical techniques were applied to admission day PSI data (1415 patients, 116 deaths) from four PICUs. The resulting PRISM score consists of 14 routinely measured physiological variables and 23 variable ranges. The PRISM score was tested in a different sample from

six PICUs (1227 patients, 105 deaths) using chi-square goodness-of-fit tests and receiver operating characteristic (ROC) analysis. It was found that the number and distribution of survivors and non survivors and mortality risk was accurately predicted.

TABLE 1: PRISM SCORE

Variable	**Age restriction and range**		**Score**
	Infants	Children	
Systolic BP(mmHg)	130-160	150-200	2
	>160	>200	6
	55-65	65-75	2
	40-54	50-64	6
	<4 0	<50	7
Diastolic BP (mmHg)	>110(all ages)		6
Heart rate (beats/min)	>160	>150	4
Resp rate (breaths/min)	61-90	51-70	1
	>90	>70	2
	Apnea	Apnea	5
PaO2/FIO2	200-300 (all ages)		2
	<200 (all ages)		3
PaCO2	57-65 (all ages)		1

	>65 (all ages)	5
G C S	<8	6
Pupil reaction	Unequal/dilated	4
	Fixed and dilated	10
PT/PTT	1.5x control	2
Total bilirubin (mg/dl)	>3.5(> 1 month)	6
Potassium (mEq/L)	3.0-3.5	1
	6.5 – 7.5	1
	<3.0/ >7.5	5
Calcium (mg/dl)	7.0-8.0	2
	<7 / >15	6
Glucose(mg/dl)	40-60	4
	250-400	2
	<40 / >400	8
Bicarbonate (mEq/L)	<16	2
	>32	3

Development of PRISM III Score [7]

A new pediatric physiology based score for mortality risk, Pediatric Risk of Mortality III (PRISM III) has been developed. This was developed involving 32 PICUs. Physiological data included the most abnormal values from the first 12 and second 12 hours of the PICU stay. Outcome and descriptive data was also analysed. Variables were stratified by age (neonate, infant, and child, adolescent). Data was collected from 11,165 admissions and 543 deaths. The PRISM III has 17 physiological variables subdivided into 26 ranges. The PRISM III is said to have a better age adjustment for selected variables. Analysis revealed no difference in mortality prediction between 12 hour and 24 hour scores.

Variables in PRISM III but not in earlier PRISM include temperature, pH, PaO2, creatinine, BUN, white blood cell count and platelet count.

TABLE 2: PRISM (III) SCORE

Cardiovascular/ Neurological Signs

Systolic Blood Pressure (mmHg)

	Score = 3	Score = 7
Neonate	40-55	<40
Infant	45-65	<45
Child	55-75	<55
Adolescent	65-55	<65

Heart Rate (beats per minute)

	Score = 3	Score = 7
Neonate	215-255	>225
Infant	215-225	>225
Child	185-205	>205
Adolescent	145-155	>155

Temperature

All ages Score = 3 <33deg C (91.4F) or >40degC (104.0F) Score=11

Pupillary Reflexes

All ages Onefixed Score=7 both fixed

Mental Status

All ages Score = 5 Stupor/Coma (GCS < 8)

Acid – Base/Blood Gases

Acidosis

Score = 2 pH= 7.0 - 7.28 pH=7.48-7.55

Score= 6 pH < 7.0 pH >7.55

Total CO_2 mmol/l

Score = 4 >34.0

PCO_2 mmHg

Score = 1 50.0 – 75.0

Score = 3 >75.0

PaO_2 mmHg

Score = 3 42.0-49.9

Score = 6 <42.0

Biochemistry

Glucose
Score = 2
>200 mg/dl

Potassium
Score=3
>6.9 mmol/l

Creatinine

	Score=2
Neonate	>0.85 mg/dl
Infant	>0.90mg/dl
Child	>0.90mg/dl
Adolescent	>1.30mg/dl

Blood Urea Nitrogen

	Score = 3
Neonate	>11.9mg/dl
All other	>14.9mg/dl

Hematology

White Blood Cell count (cells/mm3)

Score=3
<3000

Platelet Count (cells/mm3)

Score=2	Score=4	Score=5
1-2 lakhs	50000-1lakh	<50000

ProthrombinTime(PT) or
Partial Thromboplastin time
Score = 3

Infant	PT>22.0 or PTT > 85.0
All other	PT>22.0 or PTT > 57.0

Statistical Analysis:

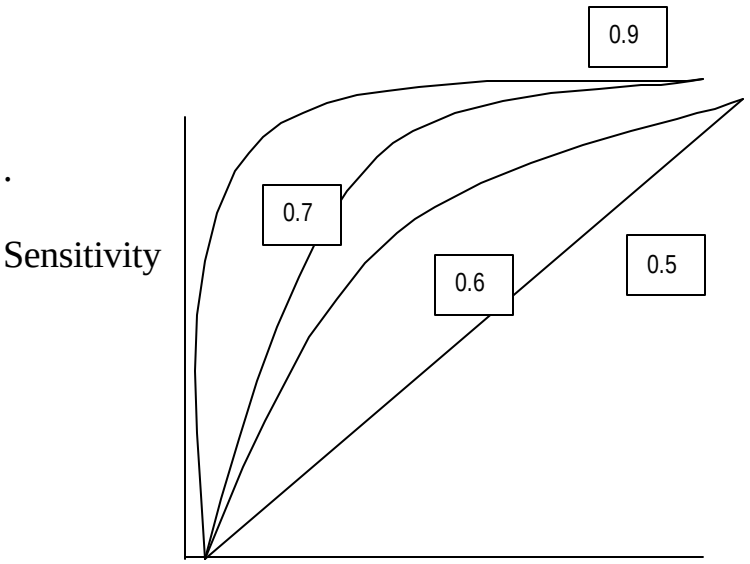
Receiver Operating Curve:

During validation of a scoring system, the discrimination and calibration are measured. Discrimination tests the ability of a model to determine patients who live (when death is the outcome variable) from patients who die. The cutoff points of probability are plotted to give a receiver operating characteristic (ROC) curve. The greater the true positive rate to the false positive rate, the greater is the area under the ROC curve. The area may range from 0.5 (purely due to chance) to 1.0 (perfect). Calibration tests the extent of agreement between the expected and actual numbers of hospital deaths across subgroups of patients. The agreement across the whole range is tested using the goodness of fit statistics.

The ROC curve is a graphical representation of the discriminative power of a test. Any biological variable e.g. hemoglobin has a range of normal values. If one cut off point is chosen to differentiate normal from abnormal, at the extremes of the range there are bound to be false positives and false negatives. Based on where the cut off point is assigned the test will return either many false positives (specificity poor but sensitivity good) or many false negatives (sensitivity poor but specificity good). Thus we require that optimal cutoff point where both sensitivity and specificity are optimal.

For any particular test (a laboratory value or scoring system) various cut off points are plotted as sensitivity (true positives) against true negatives (1-specificity). The resulting curve is the ROC curve. The curve demonstrates the discriminative power (to separate for example recovery from death in a mortality score) at various score points. The test is said to have good performance if the area under the curve nears 1. A 0.5 result is interpreted as worthless as this could be by pure chance and the laboratory test or scoring system has not had a good discriminative power. The following ROC curve demonstrates the area under the curve and its interpretation.

FIGURE 1 RECEIVER OPERATING CURVE AND ITS DISTRIBUTION



A rough guide for classifying the accuracy of a diagnostic test is the traditional academic point system:

.90-1 = excellent (A)

.80-.90 = good (B)

.70-.80 = fair (C)

.60-.70 = poor (D)

.50-.60= fail

Statistical analysis was also performed using both univariate and multivariate analysis. Risk factors that were seemed to significantly contribute to mortality after univariate analysis were further analysed using logistic regression multivariate model the factors studied included PRISM III , assisted ventilation, Glasgow Coma Scale , Shock, age and sex .

Need for New Scores:

The relationship between physiological status and morbidity risk may change as new treatment protocols, therapeutic interventions and monitoring strategies are introduced. Patient populations may also change

as new therapies ameliorate the requirement for ICU care. The new patient characteristics have to be incorporated into the scoring database. Newer scores avoid therapeutic variables that may be unduly influenced by practice patterns.

Limitations of Scoring Systems:

Every score has an average miscalculation rate of 10-15%. The following are the important limitations in the area of prognostic scoring systems.

Certain limitations have been identified in the use of scoring systems.

1. Limitation of application: Detailed instructions as to how to apply the system are not mentioned often. For instance, inclusion criteria, time period of data collection and different outcome variables are not provided.

1. Limitation of data collection in scoring: The original database for development varies in validity, reliability and completeness. The details of this are rarely reported. Generally, missing data are reported as normal. The confounding effect of this on the scoring is not made clear.
2. Limitation of accuracy of scoring systems: Due to insufficient adjustment of case mix in the original database, the scoring may not be valid in all racial and hospital settings.

3. Limitation in interpretation of results: Scoring systems like TISS (Therapeutic intervention scoring system) look at therapy used; the therapy employed may not be available in all ICUs. The Treatment practices may vary from one ICU to another. Further, the appropriateness of the therapy chosen is not verified. The probability data from scoring systems have to be evaluated with the understanding of these shortcomings.
4. Though death is the most "convenient" outcome variable, merely using mortality prediction scores ignores quality of life or morbidity issues. Also, it disregards the group of physiologically stable patients who need intensive observation not possible without an ICU setting. Though these patients may have a low score based on the predictive models, their need for ICU care cannot be disregarded.
5. None of the scoring systems can be used to predict individual patient outcome.
6. Resource utilization is an important aim of scoring systems. Patients, who are moribund with a very high probability of death, survive for only a few hours in the ICU. These patients derive little benefit from the ICU. However, as hospitals by protocol admit these patients to the ICU; their high mortality prediction score has little value.

7. Scores based on therapeutic interventions have the fallacy of physicians' perception of illness. There is no way to ensure a uniform system of interventions for a variety of problems and PICUs.

8. Current scoring systems do not account for changes in the status of a patient in the ICU for a prolonged duration. It is unlikely that a score computed at admission will predict the outcome of a long term patient.

REVIEW OF LITERATURE

A number of studies have been done using the PRISM score. These primarily look at three aspects:

1 Validation of usefulness of PRISM score

2 New ways of utilizing this score

3 Comparison of the PRISM to other scoring systems.

Validation of Usefulness of PRISM Score :

Gemke et al [8] studied the utility of the score in a Dutch PICU and found close agreement between pediatric ICU mortality rate in the study population compared to the original American study. Kanter et al [9] showed that pre-ICU PRISM score to be a good measure of illness severity and that it provides an estimate of hospital mortality. In their study, a score of 24 meant a higher than 50% chance of mortality. Proulx et al [10] observed multiple organ failure during PICU, age <12 months and PRISM score on the day of admission to be independent risk factors of death. Tan et al [11] from Singapore showed accurate prediction of mortality with the PRISM III score.

However, all workers have not found the positive results. Wells et al [12] from South Africa found poor discriminatory performance of the PRISM score. This was uniform for all age groups and diagnostic categories. Particularly important was the poor performance in infants. The overestimation of severity of illness in infants by this score was also studied by Goddard [13]. A study from Thailand [14] compared PRISM scores in their patients with respiratory failure. While there was a statistically significant difference between the scores of survivors to non-survivors, they found that PRISM under predicted mortality in their population. It is interesting to note that these studies were not based in the United States. It clearly showed that the score was not population independent and that demographic characteristics and disease patterns might have caused the poor performance of the score.

The limitation of the PRISM score in acute renal failure in children has been described by Fargason et al [15]. They found a considerable overlap of scores between survivors and non-survivors. Children with acute renal failure secondary to other diseases had a higher mortality than those with primary renal disease. However, the scores underestimated mortality in the former group. Thus it was argued that the PRISM score cannot be used to decide which critically ill children would benefit from dialysis.

The applicability of the PRISM score has been tested in various other scenarios. Monroe et al [16] has shown the application of PRISM in triage of diabetic ketoacidosis.

Pollock et al [17] found significantly more infections (10.8%) occurred in those with higher compared to lower (3.4%) scores. However, it was found that though sensitivity is 75% (75% 0f those with infection have a higher score), the positive predictive value is only 11%, i.e. Only 11% of those identified as having a high score will develop a nosocomial infection.

Orr et al [18] studied the possible use of PRISM score to estimate the requirement of interventions during the transport of a critically sick child. They found that the score underestimates the requirement for both intensive care and interventions during inter-hospital transport. It was found that low scores had a low negative predictive value; i.e. they were not necessarily at low risk despite their low scores.

The use of PRISM in submersion injuries has been studied by Zuckerman et al [19]. They found that the PRISM score accurately distinguished patients who would die or suffer neurological impairment. The score cutoff was 25. However it is interesting to note that the assessment of score was done in the emergency department and not in the PICU. This difference in time of assessment and assigning of scores has

been termed “lead time”. It is a cause for concern when assigning scores in PICU, as any stabilization of patients’ condition in the emergency department will not be reflected in the ultimate PRISM score. The PRISM scoring done in the PICU at admission has no ability to score for interventions already performed before the PICU admission. This will no doubt lead to lower scores in children who would have presented with markedly abnormal physiology.

Comparison of PRISM with other Scoring Systems:

Though specific scoring systems have been developed for trauma, the PRISM score has also been evaluated for its role in trauma assessment. Castello et al [20] compared the use of ISS (Injury Scoring System) to PRISM. PRISM was more sensitive an indicator of resource utilization but less sensitive for determining risk adjusted mortality compared to ISS. It was also found that PRISM underestimates the mortality associated with head trauma.

The PRISM score has also been evaluated for specific disease states. Leteurtre et al [21] compared the PRISM to the PIM (Pediatric Index of Mortality) in children with meningococcal septic shock. They found that the PRISM worked better than PIM and was as good as the specific scores.

New ways of using PRISM score:

The validity of the PRISM score done at the time of admission has been debated when the patient has to stay in the ward for a long time. A patient in the PICU for an extended period has an admission PRISM score which may not predict his/her ultimate outcome several days later. Balakrishna et al [22] in their study found a sensitivity of 48% and specificity of 99%. They elucidated the fact that prediction was most accurate when the stay was between 1 to 4 days.

The aim of scoring systems has always been to simplify and decrease the number of parameters needed for assessment while maintaining the accuracy of prediction of the desired outcome variable. It is interesting to note that Pollack et al[6, 7] the original authors of the Prism score have compared various PICUs using PRISM score where there has been missing data. This usually occurred when a particular variable which is part of the score, is a laboratory parameter which is clinically not required for that particular patient. Pollack et al have shown that these missing variables which were clinically not indicated do not affect the ultimate scoring or prediction. It is common practice to score "Zero" when a parameter is not measured.

Scoring Systems in Indian Intensive Care Units:

The use of scoring systems in ICU's in India is limited. Eapen et al [23] used the APACHE II [24] score and compared it to the modified organ system failure (OSF) score.

The APACHE II was applied to a neurology-neurosurgery ICU in a municipal hospital in Bombay by Parikh [25]. The mortality rate was higher than the west but similar care was much cheaper. Singhal et al [26] from St.John's hospital, Delhi, have applied the PRISM score and demonstrated its usefulness. They studied 100 patients with 18 died and 82 survived. Among them, 49 children had the score of 1-9 with a mortality of 8.2% and 45 children with the score of 10-19 with a death of 24.4%. There were 3 patients with the score of 20-29 with a considerably higher mortality of 33.3% and 3 patients with the score >30 had the highest mortality of 66.3%. ROC analysis in their study showed area under the curve of 72%.

With better understanding and newer technology in pediatric critical care more studies with the use of standard scores are required. These should aim at:

1. Validating current scoring systems
2. Modifying current scores to our unique demographic and disease pattern
3. Establishing standards of care based on the above

The present study aims at using the PRISM III score in an Indian PICU to validate its usefulness and study further applications of such a score in a Tamilnadu government tertiary care hospital setting.

JUSTIFICATION FOR THE STUDY

Following rapid advances in medical therapy and critical care technology in recent years, coupled with the spiraling cost of medical care, outcome analysis including mortality risk prediction is important for the physicians.

Institute of Child Health and hospital for Children is a tertiary care centre in the government sector which is the principal referral unit providing treatment free of cost not only for the children from the state of Tamilnadu but also from the neighbouring states like Andhra Pradhesh. During 2005, There were about 37000 patients admitted to this hospital with a total death of 1831(4.9). Total number of patients admitted to Pediatric Intensive Care Unit (PICU) were 984 with a mortality of 402 (40.8%) in the same year indicating that PICU has nearly 10 times more mortality than overall mortality of ICH. The admission and mortality rate for the whole hospital and PICU for the year 2003, 2004 and 2005 are given in the table 3. So mortality risk prediction will be a useful tool for the intensivists for counseling of parents as well as for resource allocation. Being the most important referral centre for South India and one of the largest pediatric

hospitals in South Asia, performance of the PICU, ICH can be compared with the other PICUs by using PRISM III score.

TABLE 3: MORTALITY PATTERN IN INSTITUTE OF CHILD HEATH

	Hospital			**Pediatric ICU**		
year	No of patients	mortality	mortality %	No of patients	mortality	mortality %
2003	38037	1799	4.7	854	271	31.3
2004	38695	1839	4.7	1053	395	37.5
2005	37082	1831	4.9	984	402	40.8

OBJECTIVES

Primary:

To validate the usefulness of PRISM III score in predicting mortality in a Pediatric Intensive Care Unit in Tamilnadu government tertiary care hospital setting.

Secondary:

. To assess the factors contributing to mortality such as need for Assisted ventilation, presence of shock and poor Glasgow Coma Scale (GCS).

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METHODOLOGY

Study Design:

This study is a descriptive study to validate a diagnostic scoring system namely, PRISM III.

Study Place:

Pediatric Intensive Care Unit (PICU), Institute of Child Heath and Hospital for Children (ICH & HC), Chennai

Sample Size:

Annually, 900- 1000 children are admitted in PICU, Institute of Child Health with a mortality rate of 30-40 %. For an expected sensitivity of 85%, for the PRRISM III score to predict mortality, 119 patients need to be studied. EPIINFO software was used for calculating the sample size.

Duration:

Total duration of the study was 18 months starting from June 2004. Protocol was prepared for 3 months. Study was conducted for the next one year followed by, analysis for 3 months.

Inclusion Criteria:

All patients admitted into PICU, Institute of Child Health and Hospital For Children, Egmore, Chennai

Exclusion Criteria:

1. Patients in ICU for less than 2 hours (e.g. shifted to ICU for observation)
2. Age less than 1 month
3. Presence of multiple congenital anomalies
4. Patients admitted with continuous CPR who do not achieve stable vital signs for > 2 hours.

Characteristics of the PICU, Institute of Child Heath

The Pediatric ICU of Institute of Child Heath and Hospital for Children is a 14 bedded unit. Patients over 1 month of age to 12 years who require intensive care are admitted, with the exception of patients with trauma and burns. Admissions are primarily through the Emergency department or from the Pediatric general wards. One Professor and three Assistant Professors look after the unit. Four Pediatric post graduate residents are dedicated exclusively to the Pediatric ICU and are posted in shifts. The PICU has six ventilators. Blood gas analysis and electrolytes analysis are available at the bedside while hematology and biochemical investigations are dispatched to a central laboratory which caters to the rest of the hospital also. The PICU is also equipped with a pediatric defibrillator.

The following procedures are routinely done in the Pediatric ICU:

a. Mechanical Ventilation

b. Peritoneal Dialysis

c. Exchange Transfusion

Maneuver:

PRISM III scoring which involves both clinical and laboratory data was done once at the time of admission or within 24 hours after admission using a pretested proforma . The clinical condition at arrival to the PICU was documented and not the condition at arrival to the Emergency department. For variables1–5 (clinical parameters) the most abnormal reading in the first 24 hours was recorded. The monitoring of the vital parameters – blood pressure, heart rate, temperature, pupillary reaction and Glasgow Coma Scale was done by the pediatric resident. For the other laboratory parameters, the values obtained at the time of admission were recorded. The patient's course of PICU stay was monitored and the duration of stay and outcome were recorded .The PRISM III scoring was assigned to each record.

System -wise classification was done. The group Infection was defined as those who with no definite focus of infection and who were not classified under any particular system. If a child had both clinical and investigative evidence of a definite focus of infection, he/she was classified under that system. The child continued to be in that group irrespective of further complications in the PICU which may have been the immediate cause of death e.g. a ventilator associated pneumonia in a child with viral encephalitis. For the purpose of analysis, those patients who were discharged against medical advice were included in the deaths as has been done in previous studies.

RESULTS

Children who fulfilled the inclusion and exclusion criteria and whose parents consented to be included in this study were enrolled. A total of 120 such children were studied. The results are presented in the following order.

I. PRISM III SCORE

a. PRISM III score

b. PRISM III score and mortality

c. Receiver Operating Curve (ROC)

II.CLINICAL PICTURE

a. age distribution

b. sex distribution

c. clinical diagnosis

d. duration of stay

III. ASSOCIATED FACTORS

a. presence of shock

b. need for ventilatory care

c. Glasgow Coma Scale of less than 8

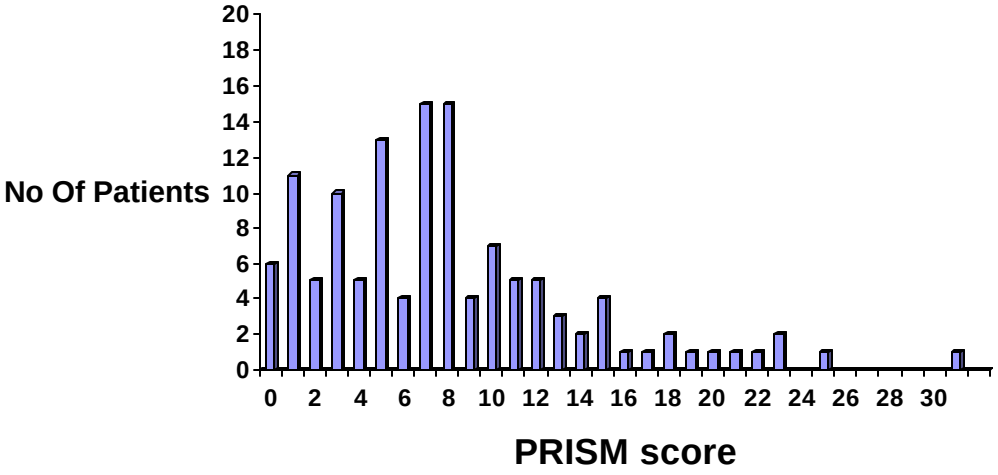
IV. UNIVARIATE ANALYSIS

V. MULTIVARIATE ANALYSIS

PRISM III Score

The minimum PRISM score in this study was 0 and the maximum PRISM score was 31 with a mean of 7.92. The mode is 8 and the median is 7. The mean PRISM III score for those who recovered was 6.05 and for those who died was 13.54. The distribution of the PRISM score with the number of patients is shown in the following histogram. Clustering of cases occurs in the region of 7 and 8.

FIGURE 4: DISTRIBUTION OF PRISM SCORE



MEAN: 7.9

MEDIAN: 7

MODE: 7, 8

PRISM III score and Mortality

Mortality risk was found to be increasing with increase in the score. When the score increased by 1, the risk of mortality raised to 1.4 on an average. When the score was less than 7, the mortality risk was only 8% while between 7 and 10 (including those who scored 7 and 10) the risk was 24% which clearly showed that there was a 3 fold increase in the death risk.. If the score was more than 10, the risk had raised to 70% with 7 fold increase in the mortality than those who had the score less than 7 which is given in the table 4.

TABLE 4 : RANGES OF PRISM SCORE AND MORTALITY

No	Prism	Total patients	Mortality	Mortality%
1	<7	49	4	8
2	7 – 10	41	10	24
3	>10	30	21	70

CHILDREN WITH PRISM SCORE <8 AND THOSE WHO HAVE >8:

Based on experience with the previous studies, cutoff for the PRISM score which delineates the higher mortality risk from the lower mortality risk was calculated as 8 and analysis was done for those who had score more than 8 and those who had 8 and below which showed a p value of 0.00 which was statistically significant as shown in the table 2. Those who have a score of less than 8 had a mortality risk of 11.4 % and those who crossed it had 63.4% mortality risk.

TABLE 5 : PRISM SCORE ≤ 8 AND MORTALITY

	Discharged		**Died**	
Prism Score	**N**	**%**	**n**	**%**
≤ 8	70	88.6	9	11.4
> 8	15	36.6	26	63.4

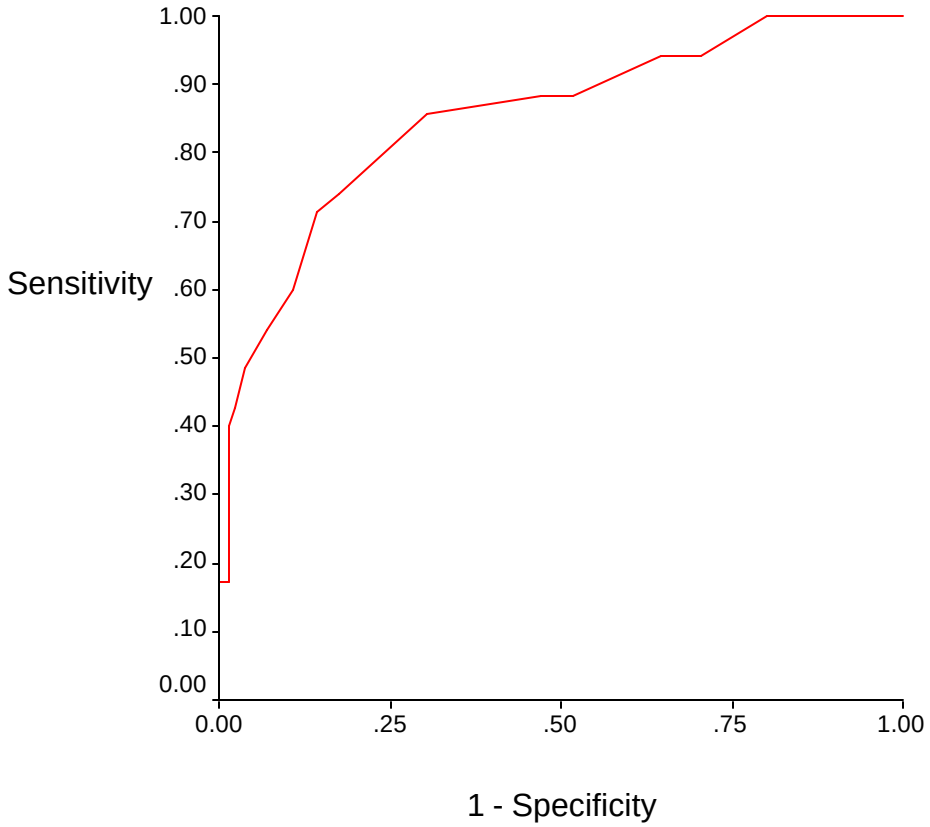
Chi square value: 35.35

P-value: 0.00

Receiver Operating Curve

In this study, the area under the ROC curve is 0.853 and the 95% confidence interval is 0.78, 0.93. The best cutoff is at 8 with a sensitivity of 74% and specificity of 82%. The Prism score would be considered to be "good" at predicting mortality.

FIGURE 2: RECEIVER OPERATING CURVE



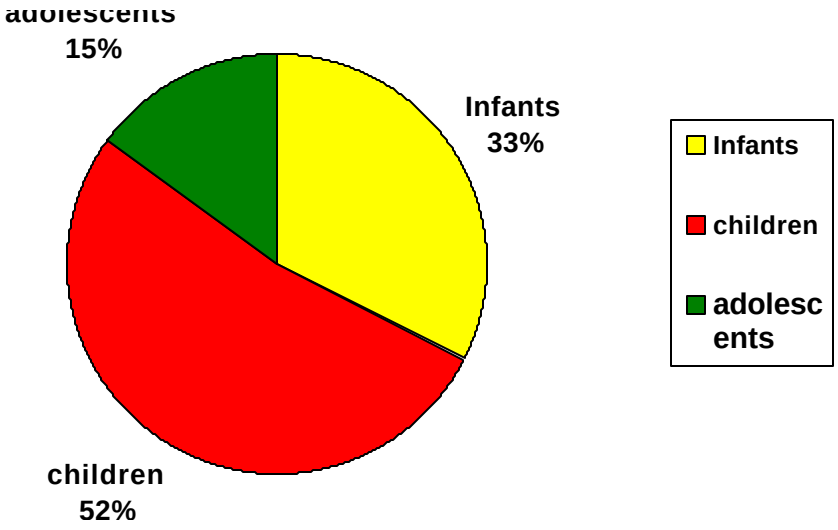
Area under curve :0.853

Clinical Picture:

Age distribution:

Among them, 39 were infants (those who were less than 1 year including those who were 1 year old), 63 were children (between 1 and 10 years of age- excluding 10) and 18 were adolescents i.e. Those who aged 10 years and above. The average age of children studied was 4.11 years (range: 1 month – 12 years).

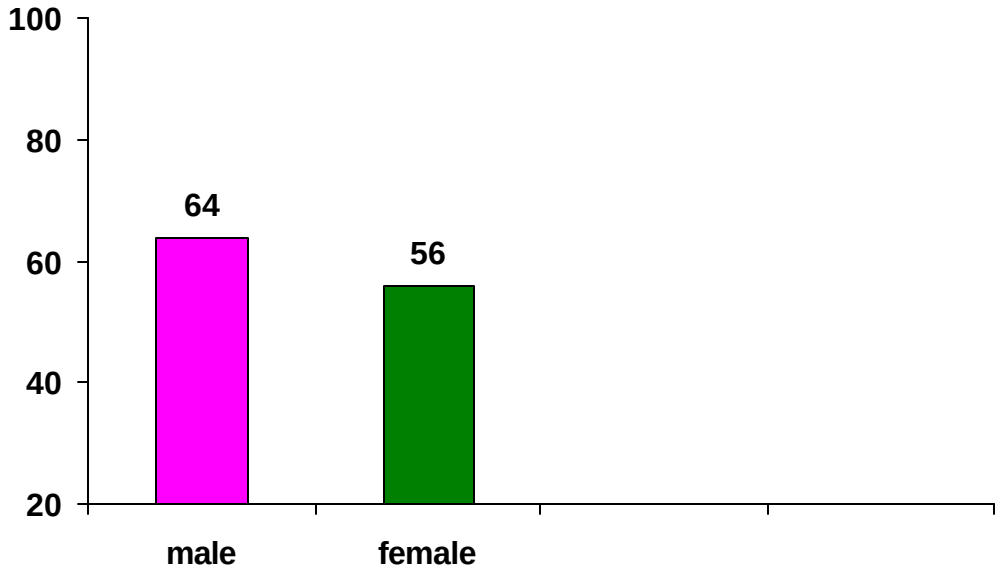
FIGURE 3: AGE DISTRIBUTION



Sex Distribution:

In this study of 120 children, 56 children were females and 64 were males. 65 children were directly admitted from the Emergency Room (E.R.) and the rest were transferred in from the general pediatric ward, who became sick and needed intensive care, during their stay in the general pediatric wards.

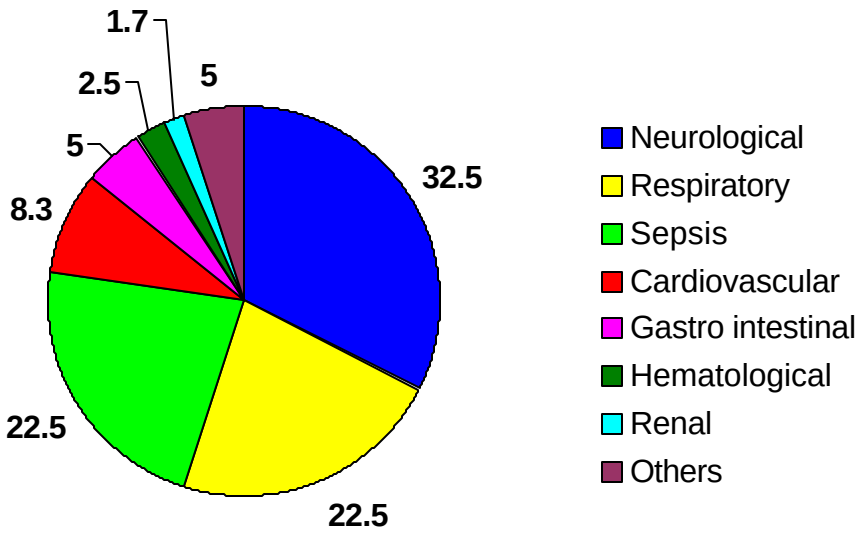
FIGURE 4: SEX DISTRIBITION



Clinical diagnosis:

Diagnosis of the children enrolled was classified based on the system involved and the distribution of the diseases is given below. Neurological diseases were the major cause for admission to the PICU, followed by Respiratory diseases, Infections, Cardio Vascular diseases, Gastro Intestinal Diseases, Renal and Hematological diseases.

FIG 5: CLINICAL DIAGNOSIS



The diagnoses of the children were classified into 7 broad categories and are given in table. Because of the small sample size, children with snake bite, scorpion sting and diabetic keto acidosis were included in the others' list as shown in the following table.

TABLE 5: DIAGNOSIS AND MORTALITY ANALYSIS

Diseases	**Total**	**Discharged**	**Discharged%**	**Died**	**Died%**
Neurological Diseases	36	25	64.1	11	35.9
Respiratory Diseases	27	22	81.5	5	18.5
Infection	27	20	74.1	7	25.9
Cardiovascular Diseases	17	7	70	3	30
Gastrointestinal diseases	6	1	17.7	5	83.3
Hematological diseases	3	1	33.3	2	66.7
Others*	6	6	100	0	0

*includes snake bite, Diabetic keto acidosis, scorpion sting

The following table shows the distribution of the Neurological diseases, which formed the major clinical diagnosis admitted in PICU and it is given in the following table.

TABLE 6 : NEUROLOGICAL DISEASES AND MORTALITY

Diagnosis	**No of cases**	**%**	**Mortality**	**%**
Neurological diseases	**39**	**32.5**	**14**	**35.9**
Acute encephalitis	15		8	
Pyogenic meningitis	10		3	
Seizure disorder/status epilepticus	6		0	
Gullaine-Barre syndrome	2		0	
TB meningitis	2		0	
Cervical cord lesion	2		2	
Hydrocephalus with SIADH	1		0	
Bulbar palsy	1		1	

Respiratory diseases and Infections were major disease categories that were admitted in our PICU. Distribution and mortality pattern is given in the following table.

TABLE 7: RESPIRATORY DISEASES AND INFECTION AND THEIR MORTALITY

Respiratory diseases	**27**	**22.5**	**5**	**18.5**
Bronchopneumonia	18		2	
Pyopnemothorax	2		1	
Pneumothorax	1		1	
Bronchial asthma	1		0	
Croup	1		1	
Bacterial tracheitis	1		0	
Bronchiectasis	1		0	
Vocal cord palsy	1		0	
Bronchiolitis	1		0	
Infections	**27**	**22.5**	**7**	**25.9**
Dengue hemorrhagic fever	17		4	
Septic shock	8		3	
Cerebral malaria	2		0	

TABLE 8 MINOR CLINICAL DIAGNOSES AND MORTALITY

Diagnosis	**Cases**	**%**	**mortality**	**%**
Cardio vascular diseases	**10**	**8.3**	**3**	**30**
Congenital acyanotic heart diseases	7		2	
Myocarditis	2		0	
Congenital cyanotic heart disease	1		1	
Gastro intestinal diseases	**6**	**5**	**5**	**83.3**
Hepatic encephalopathy	4		4	
Neonatal cholestatic syndrome	1		1	
Extra hepatic portal hypertension	1		0	
Hematological diseases	**3**	**2.5**	**2**	**66.7**
Hematological malignancies	2		1	
Bleeding disorder	1		1	
Renal diseases	**2**	**1.7**	**1**	**50**
Acute renal failure	2		1	
Others	**6**	**5**	**0**	**0**
Scorpion sting	2		0	
Diabetic ketoacidosis	2		0	
Snake bite	1		0	
Unknown bite	1		0	

Rest of the disease categories like Cardio vascular diseases, Gastro intestinal diseases, Hematological diseases and others formed only 27 cases out of 120 cases studied (22.5%) which is given in the table 8.Mortality is highest for Gastro Intestinal diseases followed by Hematological and Renal diseases. Majority of Gastro intestinal diseases to get admitted in our PICU were children with stages of hepatic encephalopathy which had a very poor prognosis.

Duration of Stay Analysis:

Average duration of stay in the PICU was 6.4 days (range 8 hours to 58 days). The median for those who died was 3 and those who were discharged was 4. This is depicted in table 8.

TABLE 9 : DURATION OF STAY AND MORTALITY

	Discharged	**Died**
Duration of stay in PICU in days[Median]	4	3

Associated Factors Analysis:

Common risk factors for poor outcome like age less than 1 year, patients with a Glasgow Coma Scale score of less than 8, those who presented with shock , those who required mechanical ventilation to find out whether there was any significant association. Sex was also analyzed for poor outcome. Variables like sex ,age and shock did not show any statistical significance.

TABLE 10: ASSOCIATED FACTORS AND MORTALITY

	Alive		Dead		Odds Ratio	p-value
	N	%	n	%		
Age					0.93	0.83
≤1 year	28	71.8	11	28.2		
> 1 year	57	70.0	24	30.0		
Sex					1.46	0.83
Male	43	75.3	21	24.7		
Female	42	83.5	14	16.5		
Shock					2.65	0.05
Present	44	63.8	25	36.2		
Absent	41	80.4	10	19.6		
Ventilation					12.58	0.00
Required	39	54.9	32	45.1		
Not required	46	93.9	3	6.1		
GCS score					6.18	0.00
≤8	30	52.6	27	47.4		
>8	55	87.3	8	12.7		

But variables like assisted ventilation, Glasgow Coma Scale of less than or equal to8 and PRISMscore of less than or equal to 8 showed statistical significance with a p value of less than 0.01 as given in the table 10.

Need for Assisted Ventilation:

In this study, 71 patients required assisted ventilation. As requirement of assisted ventilation is a risk factor for poor outcome, it was analyzed statistically. The analysis showed clearly that there was a significant correlation with a p value of less than 0.05. The average duration of assisted ventilation was 5.3 (range: 8 hours- 29 days). 28 children from emergency room and 3 children from the general pediatric ward were intubated and started on tube and bag ventilation even before they were transferred to the PICU. Rest were intubated and put on assisted ventilation in the PICU.

TABLE 10: NEED FOR ASSISTED VENTILATION AND MORTALITY

Assisted Ventilation	**Discharged**		**Died**	
	n	**%**	**n**	**%**
Required	39	54.9	32	45.1
Not required	46	93.9	3	6.1

Chi square value: 21.29

P-value: 0.00

Presence of Shock:

Presence of shock is a common indication for admission to our PICU. There were 69 out of 120 cases presented with shock. Among them 26 were admitted through emergency room and 23 were admitted from general pediatric ward. Patients presented with shock were analysed statistically with those who did not present with shock but it failed to show any significant association with mortality.

TABLE 11: PRESENCE OF SHOCK AND MORTALITY

Shock	Discharged		Died	
	N	%	n	%
Present	44	63.8	25	36.2
Absent	41	80.4	10	19.6

Chi square: 3.93

P-value: <0.05

Univariate Analysis:

Univariate analysis for the parameters like Glasgow Coma Scale, Need for assisted ventilation and PRISM cutoff of 8 were done. All had the p value of less than 0.01. PRISM score had the highest odds ratio than the other two. Those who had PRISM of more than 8 had about 14 times higher mortality risk than those with less than 8. Next to PRISM, patients who needed assisted ventilation had 13 times higher risk than who did not need it while Glasgow Coma Scale of less than 8 had a risk 6 times more than those who had more than that.

TABLE 12: UNIVARIATE ANALYSIS

	Odds Ratio	**95% C.I.**	**p-value**
GCS < 8	6.2	2.5 , 15.3	0.00
Ventilation required	12.6	3.6 , 44.2	0.00
Prism score > 8	13.5	5.3 , 34.5	0.00

Multivariate Analysis

Risk factors that were deemed to significantly contribute to mortality like PRISM III score > 8, Glasgow coma scale of less than 8 and need of assisted ventilation were further analyzed using logistic regression multivariate model. Glasgow coma scale of less than 8 failed to show stastically significant association in multivariate analysis but the other two namely, PRISM score of more than 8 and the need for assisted ventilation showed statistical significance with the outcome as shown in table 13.

TABLE 13: MULTIVARIATE ANALYSIS

	Adjusted O.R.	**95% C.I.**	**p-value**
GCS <8	2.1	0.7 , 6.4	0.20
Ventilation required	10.8	2.7 , 44.1	0.001
Prism score >8	10.4	3.5 , 30.7	0.00

DISCUSSION:

The use of scoring systems and the audit of intensive care has not been widely reported in India. There have been few studies addressing the needs of pediatric critical care. Most scoring systems are designed in the west and need to be validated in our own country. The performance of the PRISM III score in our study showed a good performance of prediction of mortality with the ROC curve analysis having an area under the curve of just 0.853. (85% correct prediction). Singhal et al [25] found the ROC analysis to be 72% in their study using the PRISM score. Their conclusion was that the PRISM score was a good predictor of mortality. Surekha Joshi et all [27] in their study in B.Y.L. Nair Hospital, Mumbai, which was presented in All India Pediatric Conference-2006 (Pedicon'2006) , found that PRISMIII score was useful in predicting mortality. Clearly the PRISM score has performed well in our study and it is comparable to the original developers who found ROC analysis (Pollock et all [6,7])of more than 90%.

The concept of lead time has to be discussed. As the PRISM scoring done at admission to PICU, the physiological instability with which a patient presents to the emergency room is not accounted for. The various therapies started in the emergency room to maintain optimal vital parameters present a falsely low score at admission to the PICU. This is obviously not representative of the true physiological disturbances e.g. the PRISM III score has no provision for scoring a hypoxic child started on supplemental oxygen or even intubated in the emergency

room. The fact that PRISM score works better if assessed in the emergency room has been demonstrated indirectly by Zuckerman [19] where PRISM was assessed in the emergency room for children with submersion injuries.

As the mean PRISM III score is significantly lower in those who were discharged (6.0) than those who died (13.5), its estimation does throw light on the severity of disease process. The PRISM III scores were equally valid in the three main subgroups of sepsis, respiratory and central nervous system disorders. These subgroups will form the majority of cases in any Indian PICU. This means that the assessment of the PRISM score in the population will provide:

1. Prediction of mortality
2. Objective measure of severity of disease
3. Ability to compare cohorts of patients with similar scores for audit and therapeutic interventions.
4. Ability to compare performance of a single PICU over time or different PICUs

When comparing the performance of PRISM III in different organ systems, the results are not very different. This has also been shown by Fargason et all[15] where patients with renal failure were assessed with the PRISM score. In that study as the prediction of outcome was poor, a decision of advising or withholding of dialysis based on the score was not possible. The number of subjects in this group is however small and larger studies will be required to demonstrate any system wise preference.

A number of queries have been raised regarding the validity of a score done at admission when the duration of stay is prolonged. However our data found no statistically significant difference in the PRISM III scores even with prolonged stay. This in no way affected the prediction of mortality.

A limitation of the PRISM III score is its need for many laboratory investigations. It cannot function as a triage score as it is expensive to do the entire set of tests required in the PRISM III score. We faced difficulty in doing arterial blood gases and coagulation profiles as every admission did not require blood gas analysis or the clotting parameters to be assessed.

Limitations of Current Study and Need for Future Studies:

The original scores were developed with larger numbers of patients and at many centres. The current study has been done on a relatively small number of subjects. The validity of a score like the PRISM III will have to be observed by a multicentric trial which will allow for larger case mix and hence more representative of an average Indian PICU.

1.The original PRISM III score has no provision for pre ICU interventions which will have a bearing on the score. The present study has not analysed the number of such patients who required therapy in the emergency room, much before the PRISM III scoring was done. The score may provide a better prediction of mortality if this is quantified.

1. Specific larger studies looking at particular disease states will be required to verify system-wise performance of the Prism III score.
2. Simpler scoring systems which do not need many laboratory parameters will allow for such systems to be used in peripheral hospitals also.
3. No individual patient decisions can be taken based on the PRISM III scoring alone. This has been a common limitation in all mortality scoring systems.
4. While the outcome variable of mortality may be acceptable in a PICU, the PRISM III has no measure of morbidity or ultimate outcome in terms of disability after transfer from the PICU. Newer scores which quantify disability and long term outcome are required to be developed.
5. One of the aims of any scoring system is the optimal use of resources. Though the PRISM III score correlates well with chances of mortality this information alone will not affect utilisation of PICU resources. No child can be denied admission to the PICU based on a low PRISM III score alone if clinically he / she warrant close monitoring. The same also holds true for a moribund child admitted with a very high score. Based on the high score and very high probability of mortality admission and therapy cannot be with held. Thus use of PICU resources will continue as required by the individual hospital's needs and no scoring system however accurate will decide the pattern of admissions.

CONCLUSIONS

- PRISM III score provides an objective assessment of the severity of illness
- PRISM III performed well as a tool to predict mortality in an Indian PICU
- Scoring systems with fewer laboratory parameters will be more useful in our context
- Larger studies are needed to develop/ validate a mortality prediction score for our country

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ANNEXURE

Proforma

Name age

Hospital number sex

Date of admission in ward:

Number of days in ward:

Date of admission in PICU:

Diagnosis and reason for admission in PICU:

Number of days in PICU:

Date of death / discharge:

PRISM III scoring

1) Systolic BP (mm Hg)

2) Heart rate

3) Temperature (^{o} F)

4) Pupillary Reflexes Normal
One fixed, one reactive
Both fixed

5) Mental Status

6) pH

7)pCO2

8)tCO2

9) PaO2

10) Glucose

11) Potassium

12) Creatinine

13) Blood Urea Nitrogen

14) WBC count

15) Platelet count

16) PT / PTT

Other Contributing Investigations:

Blood sodium:

Blood bicarbonate:

Blood NEC:

Blood leptospirosis:

Blood viral studies

Blood QBC:

Blood LFT: bilirubin total

Direct

Indirect

SGOT:

SGPT:

SAP:

Proteins Total

Albumin

Globulin

Blood smear:

Urine albumin

Sugar

Deposit

Urine culture and sensitivity:

Urine ketone bodies:

Cerebro spinal fluid: protein

Sugar

Culture and sensitivity

Cells

Xray chest:

Echocardiography:

Ultrasonagraphy - cranium

Ultrasonography - abdomen:

CT Scan:

Magnetic resonant imaging:

Scopy:

Others if any:

Diagnosis:_____ (1 / 2 / 3 / 4 / 5 / 6 / 7 / 8)

(1-Neurological diseases / 2- Respiratory diseases / 3-Sepsis / 4-Cardio Vascular diseases / 5- Gastro intestinal diseases / 6- Hematological diseases / 7- Renal diseases / 8- Others)

Outcome:__(1/2)

(1-discharged / 2- died)

Total PRISM III score: